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Research Article

Application of Heart Rate Combined with Acceleration Motion Sensor in Sports Dance Teaching

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Because of the large amount of exercise, sports dance has the characteristics of good viewing and strong movement, and has gradually entered the campus in recent years. However, sports dance is not only difficult, but also has a wide variety of categories except modern dance and Latin dance. In addition to these two categories, there are 10 kinds of dances in total. Therefore, in teaching, schools have no choice, and students cannot understand which dance styles are most effective for students' physical exercise. In order to solve the problem that there are many kinds of sports dance and the effect of students' exercise is unclear, this paper studied sports dance teaching based on heart rate combined with acceleration motion sensor, and obtained the energy consumption in sports dance teaching by using this measurement method. After comparing the effects, four kinds of dance activities, namely quickstep, waltz, rumba, and samba, which are more conducive to physical exercise, were screened out for students in the complex sports dance. In addition, in order to confirm the experimental results of the article, after the teacher improved the physical dance teaching according to the content of the article, it was found that before the experiment, the average scores of the two groups of subjects were 17.5 points and 16.75 points. After the experiment, the scores of the two groups increased by 3.5 points and 2.8 points, respectively. Through the experimental results and data, it can be shown that the research in this paper has played a good role in the improvement of sports dance teaching.

1. Introduction

Nowadays, physical education is more and more valued in schools. According to the "Opinions on Strengthening Youth Sports and Enhancing Youth Physical Fitness" issued by the State Council, in China, the Ministry of Education stipulates that the frequency of physical education is once a day and ensures that 50% of the class time is medium to high-intensity physical activity. In order to meet the country's requirements for students' physical exercise, the types and scope of physical activities have been expanded, and sports dance has also been incorporated into the elective physical education curriculum of many schools. As a relatively novel sports activity, sports dance is different from traditional running and jumping, various ball games or swimming, etc. It is also different from the ease of use of traditional dances. Because of its certain degree of difficulty, a large part of the introduction of sports dance is aimed at exercising students' physical fitness and cultivating students' professional dance skills as a secondary purpose. However, there is currently no objectively measured data on whether physical dance teaching achieves any purpose. Therefore, the objective measurement of physical activity in sports dance has a very important reference value for the specialization reform of physical education classes in the future. There are many methods for measuring physical activity, but they all have certain limitations. The physical activity questionnaire is in the form of recall and self-report, which is greatly influenced by subjectivity, and has low reliability and validity in children and adolescents. The double-labeled water method is expensive, the test cycle is long, and only the total energy consumption can be obtained. Indirect calorimetry equipment has poor portability and high operating requirements, and is often used as a calibration standard for other methods. In order to test whether physical dance teaching really plays a role in students, it is of practical significance to study the physical energy consumption of physical dance.

Because of the difficulty of physical dance coordination and the long-term nature of physical education, physical education teaching has always been a hot research topic among researchers. On the basis of factor analysis, Osadtsiv T et al. established a physical fitness level evaluation system for sports dance teaching for young dancers [1]. His research can promote the improvement of sports dance teaching, but more practical verification is still needed. Liu Y scientifically analyzed the influence of sports dance on the dynamic characteristics of the foot movement of college students. The effects of sports dance on the pressure intensity and gait characteristics of college students' insole were studied through experimental tests. His research was of great significance for guiding the force of the foot in sports dance [2]. Nonetheless, his research on foot injuries in dance was lacking. Granados D et al. introduced machine assistance, proposing a combined cognitive and physical performance feedback for assisting the dance sports learning process [3]. His research has revolutionized the teaching method of sports dance, but the teaching efficiency needs to be improved. In order to improve the effect of physical dance teaching, Wang Y studied the teaching design and application of high school dance courses based on 3D holographic technology, and designed a dance teaching process based on 3D holographic technology [4]. His research can well break down the main points and show them repeatedly in front of students, so that students can master the skills and content of dance movements. Weng X et al. conducted a research on the aesthetic training in the teaching of sports dance for college students [5]. His research has promoted the aesthetic diversity of sports dance, but the practical content is too complicated and needs to be further simplified.

In various sports or physical education, motion sensors provide assistance for our movement methods. Valero E et al. proposed a novel visual-inertial localization method, which can be directly integrated into the heart rate combined acceleration motion sensor for simulation and training [6]. Although his research was relatively novel and effective, the equipment involved was relatively expensive. Hutchinson M et al. proposed a motion sensor data collection strategy. His research was initially used to identify interference sources and avoid danger, and then also used in sports dance teaching. First, the parameters of the release source were estimated using the Markov chain Monte Carlo sampling method, and then the most informative operation was selected from a set of possible choices using the concept of maximum entropy sampling [7]. His research has demonstrated at the numerical simulation level that the performance is greatly improved compared to traditional methods, but the accuracy needs to be improved. Shin SH et al. proposed a sensor with multifunctional flexible motion [8]. His research can further expand the sensing limit, accuracy, and functionality of motion sensors, but also has the problem of being too expensive to implement. Gaidhani A et al. designed a heart rate combined acceleration motion sensor that can be used to monitor respiration during exercise, which was subsequently used in sports dance teaching [9]. His research has broadened the applicability of motion sensors, but the effect still needs long-term testing in practice.

Based on the heart rate combined with the acceleration motion sensor, this paper studied the energy consumption in sports dance teaching, drew the results, and compared them, so as to screen out the sports dance that has a good effect on students' exercise. The innovation of this article was that in addition to using Actiheart heart rate combined with acceleration motion sensor, Comsed K4b2 equipment was also used to measure the energy consumption of sports dance, which made the experimental results more accurate.

2. Method of Heart Rate Combined with Acceleration Motion Sensor

2.1. Physical Dance Teaching Mode. As an emerging sport, sports dance has quickly set off a learning boom in the campus and society with its distinctive features of social entertainment and performance competition. In order to adapt to the development of the times, many colleges and universities have successively added sports dance majors. Sports dance is a comprehensive sports event that integrates sports, art, dance, and music, and is scored in terms of basic techniques, dance styles, musical performance, choreography, field effects, and on-the-spot performance [10]. It is also a difficult and beautiful sport that is scored in six aspects: basic technique, dance style, musical expression, choreography, field effect, and on-the-spot performance. In order to achieve the best results in sports dance competitions, one can pursue superb techniques, more creative choreography, best field effects, and highly infectious expressiveness [11]. This also means that the education of sports dance in schools is very difficult. The introduction of different types of sports dance is shown in Figure 1.

As shown in Figure 1, sports dance is mainly divided into two categories: modern dance and Latin dance. There are many different dance styles under these two categories. The modern dance items include foxtrot, tango, quickstep, waltz, and Vienna waltz. Latin dance groups include rumba, cha cha, cowboy, samba, and bullfight. There are different styles of dance, each with its own characteristics. To sum up, the artistic expression of different dances has its own unique form of expression and aesthetic connotation in each art field. Due to the differences in the types of art, the cultivation of artistic expression has its own characteristics. Even so, there are commonalities in artistic expression in all fields, that is, they all pursue the harmony and unity of spiritual emotions and external skills, and have reached an emotional resonance of artistic conception.

Because of the diversity of sports dance types and the complexity and time-consuming of learning, even professional dance schools have to go through years of training to learn all types roughly. Most students will only choose one of them for intensive study. Because there are many types of dance sports, schools have limited funds for hiring teachers. It is impossible to recruit teachers to teach every

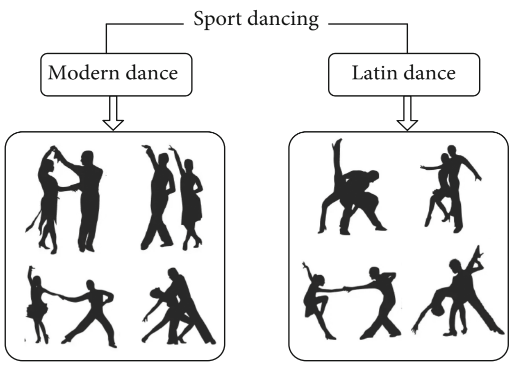

Figure 1: Schematic diagram of different types of sports dance.

type of dance, so sports dance is selective for students, both in terms of teaching and students' learning [12]. This article cannot cover all categories in the teaching of sports dance. Taking rumba as an example to make a basic explanation, rumba dance is characterized by romantic style and charming dancing posture. Both men and women pay attention to body posture. The dance is soft and graceful, and the footwork is graceful. It is more about the feeling of the body and it is relatively difficult for Cha Cha, but Cha Cha has other characteristics. Among the ten dance types, dancers have to learn different content for different dance methods [13].

2.2. Physical Fitness Measurement Methods in Sports Dance Teaching. In sports dance, the heart rate monitoring method is easily affected by factors such as emotions, body temperature, and environment, and the heart rate has a lag in response. The pedometer method cannot distinguish exercise intensity, and the accuracy is greatly affected by exercise intensity and activity type. The accelerometer is a widely used objective measurement method. The three-axis accelerometer ActiGraph GT3X+ is a commonly used accelerometer, but its accuracy is not high in the measurement of static and low-intensity physical activity. Therefore, this paper used Actiheart heart rate combined with acceleration motion sensor to study sports dance in teaching. Actiheart heart rate combined with accelerometer motion sensor (Cambridge Neurotechnology, Cambridge, UK) is currently the only measurement tool in the world that combines heart rate and accelerometer [14]. Studies have shown that Actiheart is a good predictor of physical activity in a laboratory setting. Previous studies have been conducted in the laboratory, and there has been no validation of field physical activity items in the free-moving state. The activity environment of sports dance is similar to the laboratory environment, so it is more effective to use Actiheart to objectively and accurately measure the physical activity level of sports dance.

Actiheart is currently the only heart rate combined acceleration motion sensor that can simultaneously collect heart rate and vertical axis activity counts. By converting the electronic signal into the energy consumption index, the energy consumption is estimated by using the prediction formula built in the device. Actiheart measures a wide range of physical activity of varying intensities (heart rate 31-250). It can store the collected data in the device at the end of the test. Usually, the data can be saved for 1-3 weeks. It is downloaded and exported to an Excel file via a docking station and dedicated software, which includes data such as activity counts, energy expenditure, and heart rate. In actual use, Actiheart is fixed on the corresponding test site of the chest through 3 M electrode pads. Figure 2 is the structure and measurement diagram of the Actiheart sensor.

As shown in Figure 2, Actiheart (Cambridge Neurotechnology, Cambridge, UK) is a combined heart rate and acceleration motion sensor. In actual measurement, Actiheart weighs about 8 grams and is 188 mm long, and can measure ACC, HR, HRV, and 15 s, 30 s, and 60 s of ECG. The memory capacity is 128 kb, which can store 60s of records for 11 days. Heartbeat interval and ECG waveform data can be recorded for about 24 hours and 13 minutes, respectively. Acceleration is measured by a piezoelectric element in the Actiheart, reacted by a frequency of 1-7 Hz (3 dB) and stored as counts, and counts are linearly related to acceleration by a factor of 0.003 m/s per count per minute [15]. Actiheart is tested by fixing two 3 M pads to the corresponding test site on the chest, and the two pads are placed in the lower part between leads V1 and V2 and at the position of V4 or V5.

The way to improve the accuracy of physical activity measurement is to collect a variety of activity data indicators for analysis and conversion (such as heart rate, activity count, etc.). The effect of measuring physical activity by heart rate alone is not very satisfactory, and the combination of acceleration and heart rate in the teaching of sports dance by the Actiheart motion sensor can greatly improve the accuracy of prediction of energy consumption, which is very important for the measurement of sports dance in this paper. Because in sports dance teaching, some scholars have found that the ACC+HR is more accurate than the ACC or HR alone, and the prediction ability of the ACC+HR is better. Therefore, this paper believes that Actiheart can better predict physical activity energy expenditure by effectively combining acceleration and heart rate compared to using either indicator alone (using acceleration or heart rate indicator alone) [16].

In sports dance, in order to detect the effectiveness and intensity of the activity, in addition to the Actiheart heart rate combined with the acceleration motion sensor used to measure the heart rate, oxygen consumption is also another important parameter to be measured. Therefore, this paper uses Comsed K4b2 (Comsed, Rome, Italy) gas metabolism analyzer with Actiheart sensor to measure sports dance activities in teaching. It uses the principle of indirect calorimetry to measure the oxygen consumption under various exercise intensities by analyzing the content of oxygen and carbon dioxide in each breath and calculating the energy consumption per unit time. Comsed K4b2 can measure the oxygen consumption under different sports, and is often used as the gold standard to verify the validity and reliability of the energy consumption measurement methods of other instruments. Figure 3 is the measurement principle diagram of the K4b2 equipment.

As shown in Figure 3, K4b2 can be used in combination with Actiheart in the teaching of sports dance because of its

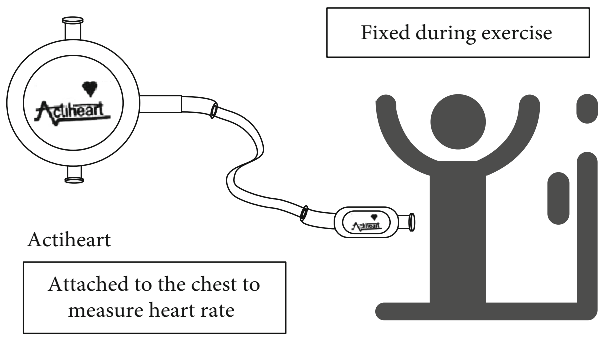

Figure 2: Actiheart sensor measurement structure diagram.

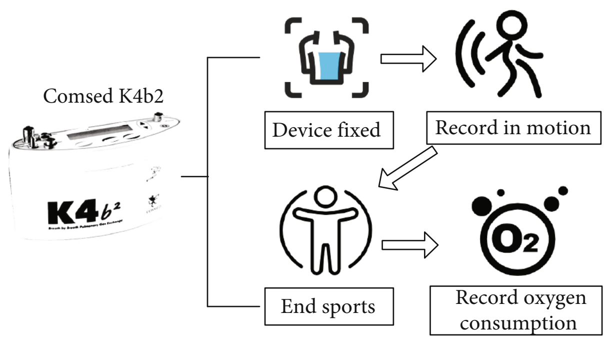

Figure 3: Measurement principle diagram of K4b2 device.

accurate measurement of oxygen consumption. The calculation of K4b2 energy consumption (Energy Expenditure, EE) adopts Weir formula:

$$\mathrm{EE}(Kcal/\mathrm{min}) = 3.9 \times (VO2) + 1.1 \times (VCO2). \quad (1)$$

Among them, EE stands for Energy Expenditure, that is, energy consumption. Kcal is the calorie consumption per minute of sports dancing. After each part of the K4b2 test, the data is exported to Excle on the computer through the built-in software of the device. The sampling interval of Actiheart is set to 60s, so the data of K4b2 is processed by JMP10.0 and converted into a time interval of 60s corresponding to Actiheart time synchronization [17]. Actiheart can derive 3 predictions with its own software, namely ACC (accelerometry), HR (heart rate), and ACC+HR to record the data per minute:

$$\mathrm{ACC} = \mathrm{a} * \left(\sqrt{A_x{}^2 + A_y{}^2}\right)^{p1} + b * A_Z{}^{p2}, \quad (2)$$

$$\mathrm{HR} = \left|\mathrm{A_z} * \frac{p1}{p2}\right|(A_x + A_y), \quad (3)$$

$$accelerometry + heart\ \mathrm{rate} = \mathrm{A_z}{}^{p} + A_x A_y. \quad (4)$$

In the formula, a, b, p1, and p2, respectively, represent coefficients related to individual characteristics (height, weight, etc.), and the data should conform to normal distribution and homogeneity of variance. The comparison between the measured value of K4b2 and the predicted value of the three Actiheart predictions can use the paired sample T test. $P < 0.05$ means the difference is statistically significant.

For the data processing of Actiheart, Matlab7.0 programming is used for calculation. The calculation formula of net energy consumption per unit time and unit weight during exercise is AEE = (Egross – Erest)/M (unit : cal/kg/min). AEE is the English abbreviation of Active energy expenditure, Egross is the English abbreviation of Gross energy expenditure, and Erest is the English abbreviation of Rest energy expenditure. The unit of acceleration integral value is per minute. The sum of acceleration integral value is defined as counts/min, which is the average value over a period of time [18]. In signal processing, the second-order cutoff frequency 17 Hz butterworth low-pass filter is used to filter the original signal. The integral value of the acceleration raw signal is often used to calculate the average acceleration. For the convenience of calculation, the following calculation formula is used to calculate the root mean square value of acceleration in the vertical direction:

$$aRMS = \sqrt{\frac{1}{T}\int_{t=0}^{T} (x(t) - \bar{x})^2 dt}. \quad (5)$$

The formula is also often written:

$$aRMS = \sqrt{\frac{1}{N}\sum_{n=1}^{N} (x_n - \bar{x})^2}. \quad (6)$$

The root mean square (RMS) of the acceleration in the horizontal direction is:

$$\mathrm{a}RMS = \sqrt{\frac{1}{N}\sum_{n=1}^{N} (x_n)^2}. \quad (7)$$

After the acceleration in the horizontal or vertical direction is detrended, the integral calculation formula is:

$$\mathrm{Ia} = \frac{1}{T}\int_{t=0}^{T} (x(t) - \bar{x})dt, \quad (8)$$

$$\bar{\mathrm{w}} = \frac{U_{ij}}{\sum_{i=1}^{n} U_{ij}} (i, j = 1, 2, \cdots n), \quad (9)$$

$$\mathrm{W_i} = \frac{\bar{\omega}_i}{\sum_{j-1}^{n} \bar{\omega}_j} (i, j = 1, 2 \cdots n). \quad (10)$$

The acceleration integral calculation formula is:

$$\mathrm{Ia} = \frac{1}{T}\int_{t=0}^{T} x(t)dt. \quad (11)$$

In the formula, the parameter representation method of acceleration root mean square and integral value is: zRMS is the root mean square acceleration of the vertical direction after detrending (minus the mean). xRMS is the root mean square of the horizontal acceleration after detrending. xRMS is the root mean square value of the original horizontal acceleration. Iaz is the integral value per minute after the vertical acceleration detrend. Iax is the integral value per minute after the horizontal acceleration is detrended. IAtot is (IAtot = Iaz + Iax) the sum of the acceleration integral per minute in the horizontal direction and the acceleration integral per minute in the vertical direction. Iaz is the integral value per minute after the acceleration in the vertical direction minus the acceleration of gravity (g).

The formula for calculating the root mean square error is:

$$\mathrm{RMSE} = \sqrt{\frac{1}{\mathrm{n}}\sum_{i=1}^{n}\left(X_{measure} - X_{presume}\right)^2}. \tag{12}$$

Among them, X measurement refers to the actual measured value, and X estimate is the estimated value using a regression.

The formula for calculating relative error is:

$$\mathrm{RE} = \frac{1}{\mathrm{n}}\sum_{i=1}^{n}\left|X_{measure} - X_{presume}\right|. \tag{13}$$

Among them, $\mathrm{X}_{measure}$ is the actual measured value, and $X_{presume}$ is the data estimated by the regression. The calculation of energy consumption during exercise is the calculation formula of net energy consumption per unit time and unit weight:

$$\mathrm{E_{net}} = \left(E_{gross} - E_{rest}\right)/Mass, \tag{14}$$

$$\mathrm{AW} = \lambda \max W. \tag{15}$$

Among them, $\mathrm{E_{net}}$ represents the energy consumption caused by exercise, E_{gross} represents the total energy consumption during exercise, and $\mathrm{E_{rest}}$ represents the most basic energy consumption consumed by the human body in a quiet state. Units in the formula: the unit of energy consumption is cal/kg/min and the unit of body weight is kg. In the AW calculation formula, λ max is the maximum eigenvalue of A, W is the corresponding eigenvector, W is normalized as a weight vector, and the maximum and minimum eigenvalues can be calculated from the weight vector. The specific formula is as follows:

$$\lambda \max = \frac{1}{\mathrm{n}}\sum_{i=1}^{n}\frac{(Aw)i}{W_i}, \tag{16}$$

$$\lambda \min = \mathrm{W_i}\left|\frac{n}{AW} * (i + AW)\right|. \tag{17}$$

In Actiheart's motion sensor data processing, because of the i element of (Aw) in the calculation formula of maximum and minimum eigenvalue $\lambda_{\max\&\min}$, it is difficult for the results in the same judgment matrix to show strict consistency. If there is complete consistency, $\lambda_{\max} = n$, and except for $\lambda_{\max} = n$, other eigenvalues are 0. In addition, the energy consumption index of sports dance activities is a single-level ranking, and it also needs to pass the consistency test, which means that the allowable range of inconsistency is determined for A. The formula for calculating the consistency and testing is as follows:

$$\mathrm{CI} = \frac{\lambda_{\max} - n}{n - 1}, \tag{18}$$

$$\mathrm{CR} = \frac{\mathrm{CI}}{\mathrm{RI}}. \tag{19}$$

After the calculation of the formula, the method and data sorting method of the Actiheart heart rate combined with acceleration motion sensor and Comsed K4b2 in sports dance activities can be summarized. Figure 4 is the technical roadmap of K4b2 with Actiheart heart rate combined acceleration motion sensor.

3. Experimental Design and Data of Sports Dance Teaching

This section will describe the simultaneous measurement of 8 common sports dance teaching activities for middle school students aged 11-17 using Cosmed K4b2 gas metabolism analyzer and Actiheart, based on the reference value measured by K4b2 indirect calorimetry. At the same time, Actiheart's three energy consumption predictions were used to estimate the energy consumption value, and the validity of Actiheart's ACC+HR, ACC and HR for predicting the energy consumption of common sports dance in adolescents was verified [19].

3.1. Objects. This study selected 65 middle school students aged 11-17 from some middle schools in Shanghai, including 24 boys and 41 girls, who were healthy and had no exercise taboos. All tests are signed by the parents and me. Table 1 is the basic information of the tested personnel.

3.2. Design. Because sports dance mainly includes two major categories, modern dance and Latin dance. The two categories of modern and Latin include many different categories, such as tango, quickstep, waltz, cha-cha, rumba, samba, etc. [20]. The elective syllabus of sports dance in most schools only stipulates the major category of sports dance, and does not specify any subcategories. Therefore, the calculation of sports dance in this paper will be compared with several common items selected by most schools. Among them, there are four types of Latin dance: Cha Cha, Rumba, Samba, and Bullfighting. Table 2 shows the content of the test dances and the specific test time. Figure 5 shows the specific flow of the experiment.

As shown in Figure 5, both parts of the test were completed in the dance studio. The tested students wear the Actiheart, and the test process is kept synchronized with the recording time of the K4b2 gas metabolism analyzer. There is a time interval between each dance activity. The heart rate returns to the resting heart rate level and then the next physical activity test is performed. Rest Energy Expenditure (REE) was measured by lying down. After the

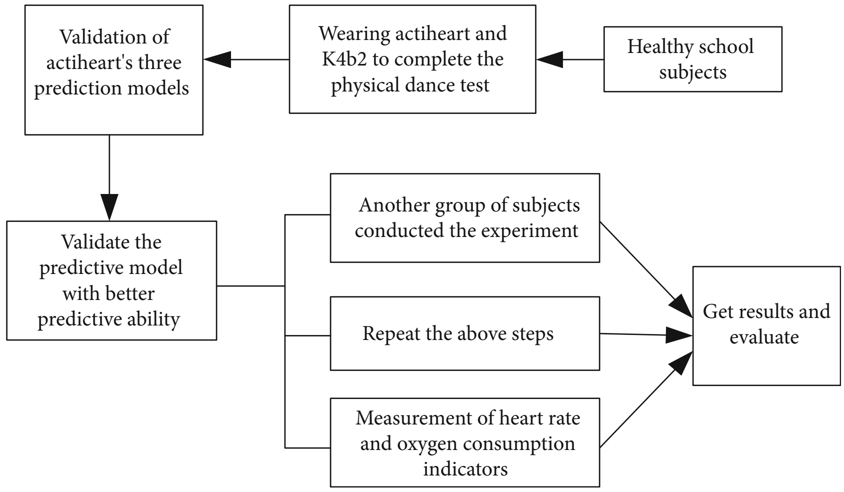

Figure 4: Technology roadmap.

Table 1: Basic information of the tested personnel.

Age	Height(cm)	Weight(kg)	BMI	Resting heart rate(bpm)
9($n = 24$)	137.46 ± 7.67	32.58 ± 9.1	13.96 ± 0.88	90.32 ± 9.01
10($n = 22$)	144.68 ± 11.5	40.56 ± 10.89	16.45 ± 0.99	90.53 ± 9.64
11($n = 24$)	149.71 ± 5.89	42.58 ± 9.45	21.33 ± 2.75	85.11 ± 10.34
Total ($n = 65$)	142.35 ± 8.29	37.45 ± 9.89	17.51 ± 2.9	88.32 ± 9.01

Table 2: Test dance content and test time.

Classification	Dance category	Time(min)
Modern	Quickstep dance	4
	Tango	5
	Waltz	8
	Vienna waltz	9
Latin	Cha cha dance	6
	Rumba	7
	Samba	5
	Bullfight dance	6

dance experiment of all students is completed, the results are summarized.

4. Results and Discussion

4.1. Comparison of Energy Consumption of Modern Dance in Sports Dance

4.1.1. Comparison of Energy Consumption between Tango and Quickstep. This section starts with the modern dance in sports dance for comparison. Two dances with different dance styles but similar dance methods are used for experiments. Then, the Actiheart heart rate combined with the acceleration motion sensor and the K4b2 device are used for calculation to test whether the ordinary sports dance teaching is effective. After the results are counted, the sports dance that is more beneficial to the students is screened and decided, and the space for the teacher to improve the sports dance movement is provided. Figure 6 shows the energy consumption comparison results of Tango and Quickstep measured by the Actiheart motion sensor.

As shown in Figure 6, in the Tango test project, with K4b2 indirect calorimetry as the standard, the energy consumption of Tango measured by K4b2 indirect calorimetry is 2.66 ± 0.34Kcal/min. The energy consumption of Tango measured by ACC+HR prediction is 1.3 ± 1.4 Kcal/min, the energy consumption of Tango measured by ACC prediction is 1.1 ± 1.2 Kcal/min, and the energy consumption value of Tango measured by HR prediction is 1.24 ± 1.29 Kcal/min. In the quick step dance test item, the energy consumption value of quick step dance measured by ACC+HR prediction is 2.33 ± 1.26 Kcal/min, and the energy consumption value of quick step dance measured by ACC prediction is 2.70 ± 1.58 Kcal/min, and the energy consumption of trot measured by HR prediction is 1.70 ± 1.23 Kcal/min. Taking K4b2 indirect calorimetry as the standard, the energy consumption of fast-step dance measured by K4b2 indirect calorimetry was 2.54 ± 1.22 Kcal/min. Through the comparison in Figure 6, it can be concluded that quickstep dance is more energy-intensive than tango, and it is easier to exercise students' physical fitness in the teaching of sports dance.

4.1.2. Comparison of Energy Consumption between Waltz and Vienna Waltz. Next, the modern dance types in another group of sports dances is measured, namely the waltz and the Vienna waltz. Although these two groups of dances look

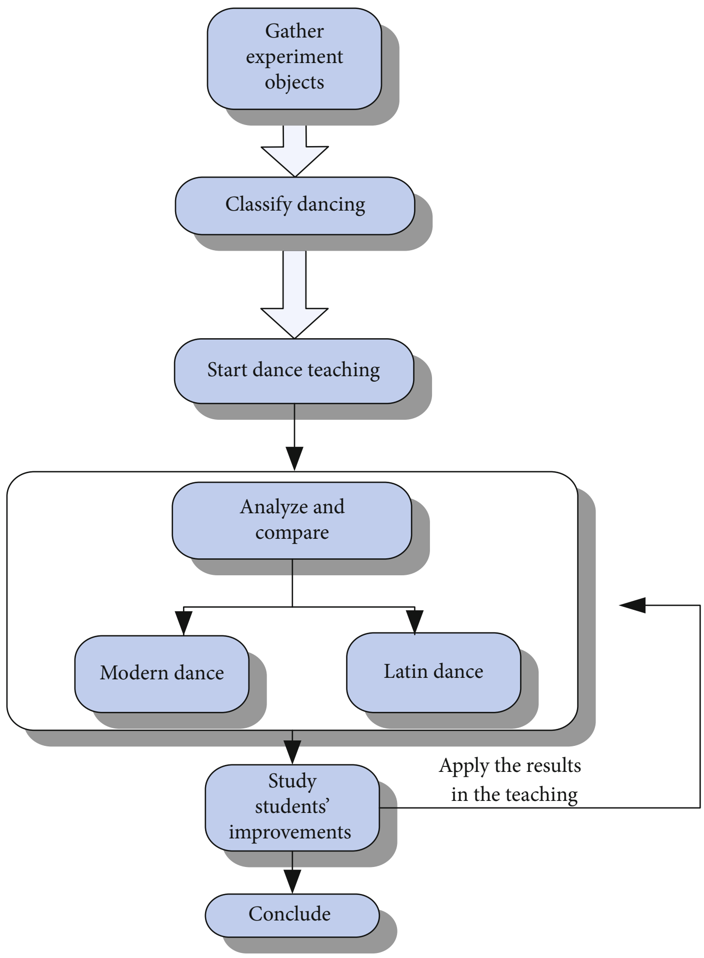

Figure 5: Experimental process.

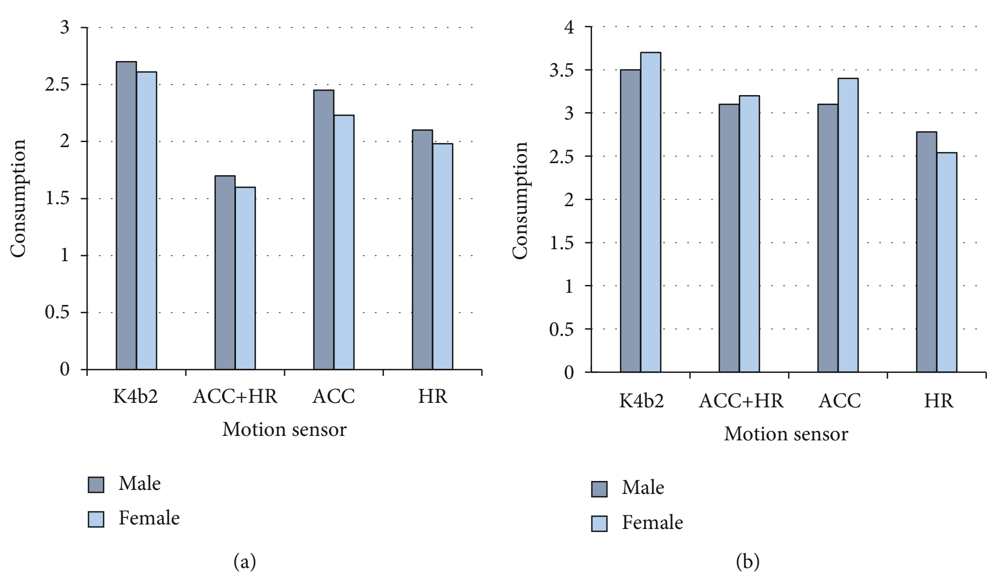

Figure 6: Comparison of energy consumption between (a) Tango and (b) Quickstep.

similar, there are differences in many movement details in the teaching. Figure 7 shows the energy consumption comparison results of the waltz and the Vienna waltz measured by the Actiheart motion sensor.

As shown in Figure 7, in the waltz test project, the K4b2 indirect calorimetry was used as the standard, and the K4b2 indirect calorimetry measured the energy consumption of the waltz was 1.85 ± 0.36 Kcal/min. The energy consumption

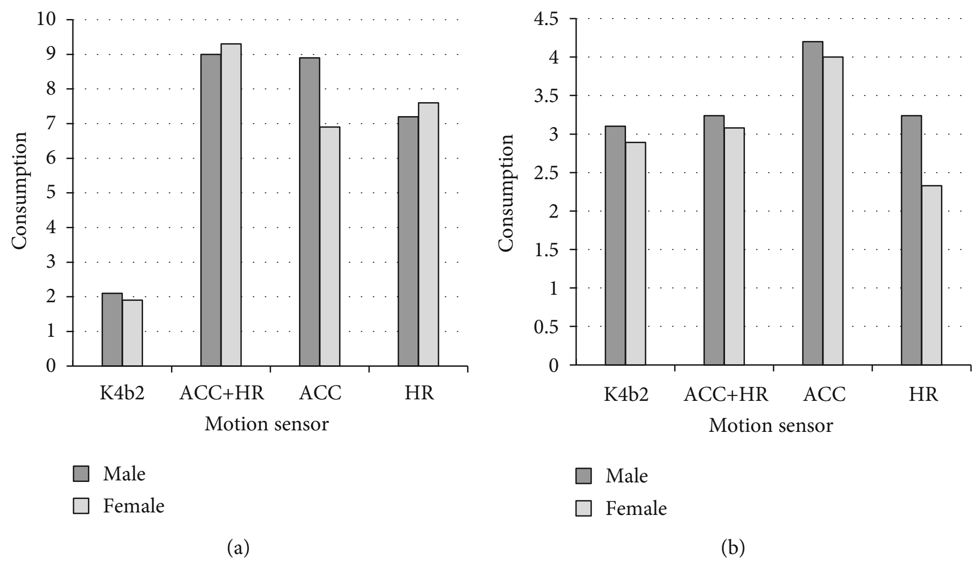

FIGURE 7: Comparison of energy consumption between (a) Waltz and (b) Vienna waltz.

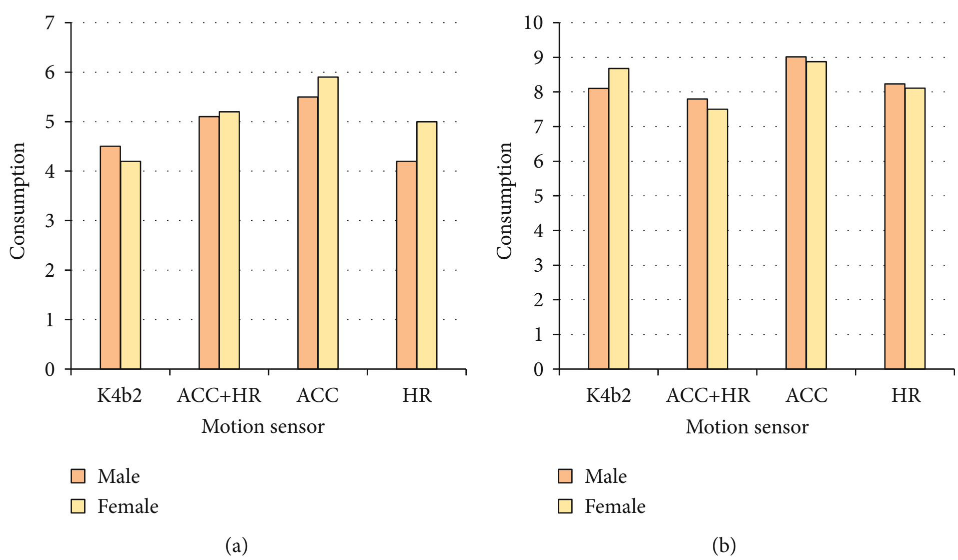

FIGURE 8: Comparison of energy consumption between (a) Cha Cha and (b) Rumba.

of the waltz measured by the ACC+HR prediction is 7.24 ± 2.90 Kcal/min, the energy consumption of the waltz measured by the ACC prediction is 7.80 ± 3.15 Kcal/min, and the energy consumption of the waltz measured by the HR prediction is 4.02 ± 3.80 Kcal/min. In the test project of the Vienna waltz, the K4b2 indirect calorimetry was used as the standard, and the K4b2 indirect calorimetry measured the energy consumption of the Vienna waltz to 2.57 ± 0.55 Kcal/min. The energy consumption of the Vienna waltz measured by the ACC+HR prediction is 2.79 ± 0.53 Kcal/min, the energy consumption value of Vienna waltz measured by ACC prediction is 3.75 ± 0.86 Kcal/min, and the energy consumption value of Vienna waltz measured by HR prediction is 2.08 ± 1.14 Kcal /min. According to the comparison of the calculation results, it can be seen that in the comparison of modern dance of sports dance, the waltz has a more energy-consuming effect than the Vienna waltz, which can play a good role in promoting the teacher in dance teaching [21].

4.2. Energy Consumption Comparison of Latin Dance in Sports Dance

4.2.1. Comparison of Energy Consumption between Cha Cha and Rumba. After the calculation of the modern dance types in sports dance, the next thing to compare is the Latin dance type in sports dance. As a common popular dance category, Latin dance is very popular in current school education. Figure 8 is the comparison result of energy consumption between Cha Cha and Rumba in Latin dance measured by Actiheart motion sensor.

As shown in Figure 8, in the test item of Qiaqia, the K4b2 indirect calorimetry method is used as the standard,

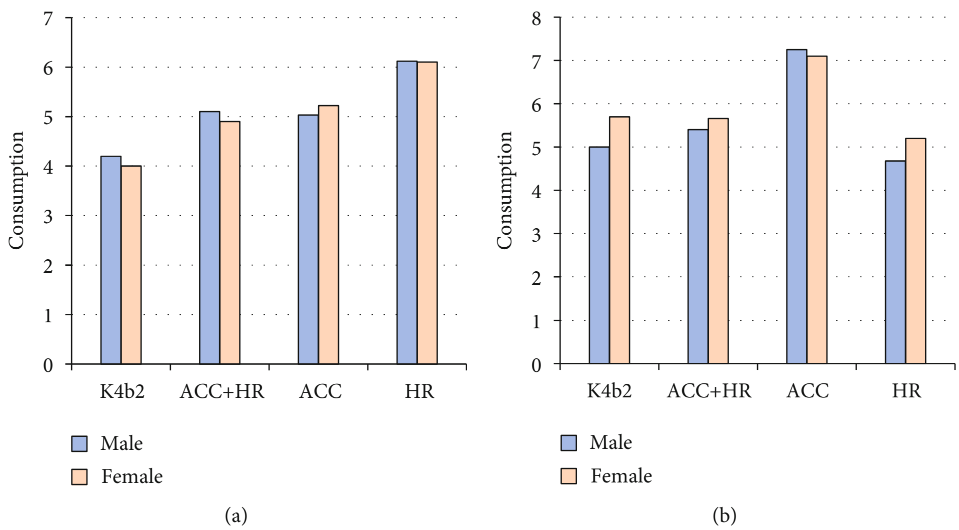

Figure 9: Comparison of energy consumption between (a) Samba dance and (b) Bullfight dance.

Table 3: Results of the physical dance skills assessment.

Variable	Test group	Control group	Test group (after test)	Control group (after test)
Variable	4.7 ± 0.1	4.65 ± 0.06	5.1 ± 0.2	4.88 ± 0.36
Action completion	5.15 ± 0.06	5.04 ± 0.84	6.3 ± 0.07	5.97 ± 0.84
Accuracy of music rhythm	4.3 ± 0.88	4.3 ± 0.35	5.4 ± 0.91	4.45 ± 0.45
Body posture and line aesthetics	5.6 ± 0.1	5.0 ± 0.83	5.8 ± 0.2	6.0 ± 0.91
Total	17.5 ± 0.28	16.75 ± 2.26	21 ± 0.31	19.55 ± 3.15

and the energy consumption value of Qiachai measured by the K4b2 indirect calorimetry method is 3.73 ± 0.99 Kcal/min. The energy consumption of Cha Cha measured by the ACC+HR prediction is 4.00 ± 1.25 Kcal/min, the energy consumption of Cha Cha dance measured by ACC prediction is 4.58 ± 1.35 Kcal/min, and the energy consumption value of Cha Cha dance measured by HR prediction is 3.34 ± 1.65 Kcal/min. In the Lombard test project, the energy consumption value of Lombard measured by K4b2 indirect calorimetry is 7.14 ± 2.00 Kcal/min, the energy consumption of rumba measured by the ACC+HR prediction is 7.19 ± 1.95 Kcal/min, the energy consumption of rumba measured by the ACC prediction is 8.05 ± 2.51 Kcal/min, and the energy consumption value of Lombard measured by HR prediction is 5.73 ± 3.48 Kcal/min. It can be seen that Cha Cha and Rumba are not only more energy-intensive than modern dance, but also more energy-intensive in sports dance teaching.

4.2.2. Comparison of Energy Consumption between Samba Dance and Bullfight Dance. Finally, the energy consumption of samba dance and bullfighting dance in Latin dance is compared. Although samba and bullfighting sounds relatively small, they are very common in some sports dance teaching today because of their exotic movements. Figure 9 shows the samba and bullfight dances measured by Actiheart motion sensors energy consumption comparison results.

According to Figure 9, in the test project of Samba, the energy consumption value of Samba measured by K4b2 indirect calorimetry is 4.00 ± 0.86 Kcal/min, and the energy consumption value of Samba measured by ACC+HR prediction is 4.15 ± 1.00 Kcal/min, the energy consumption value of Samba measured by ACC prediction is 4.65 ± 1.43 Kcal/min, and the energy consumption value of Samba measured by HR prediction is 4.27 ± 2.15 Kcal/min. The average energy consumption of bullfighting dance was analyzed, the overall energy consumption value measured by K4b2 indirect calorimetry was 3.86 ± 2.67 Kcal/min, the energy consumption value of Samba measured by ACC+HR prediction was 3.75 ± 2.70 Kcal/min, the energy consumption value of Samba measured by ACC prediction was 4.27 ± 3.01 Kcal/min, and the energy consumption value of Samba measured by HR prediction was 2.86 ± 2.68 Kcal/min. Therefore, it can be concluded that samba dance is more energy-intensive in sports dance teaching. The energy consumption experiment results of the four groups of sports dances can show that the quickstep, waltz, rumba, and samba are more energy-intensive.

4.3. Evaluation of Physical Dance Teaching for Improved Energy Consumption Results. Through comparison and summarization, it can be concluded that quickstep, waltz, rumba, and samba are more suitable for students to train in sports dance. After experimenting on the energy consumption in sports dance through the Actiheart heart rate acceleration motion sensor, the teacher will then inform the teacher of the experimental results. The basic situation of dance sports skills and interest level in sports dance learning was analyzed [22].

Before the experiment, the teacher divided the experimental group into two groups according to their dance level, and conducted an assessment of the physical dance skills of the two groups of respondents. The survey results are shown in Table 3.

From the table, it can be found that before the experiment, the average score of the respondents in the experimental group was 17.5 points, while the average score of the respondents in the control group was 16.75 points. After the experiment, the scores of the two groups increased by 3.5 points and 2.8 points, respectively. Through the data, it can be found that the experiments in this paper have also played a role in the improvement and application of sports dance in schools.

5. Conclusion

Based on heart rate combined with acceleration motion sensor, this paper studied sports dance teaching. Heart rate combined with acceleration motion sensor has a great role in each exercise, which was reflected in the measurement of heart rate and energy consumption. By using this measurement method to obtain the effect of energy consumption in sports dance teaching, it can screen more targeted and more conducive dance activities for physical exercise for students in complex sports dance. The Actiheart heart rate combined with acceleration motion sensor used in this paper was the only measurement tool in the world that combined heart rate and accelerometer. At the same time, the Comsed K4b2 gas metabolism analyzer was combined with the motion sensor to conduct experiments on the energy consumption of the measured dance activities. The test results of the article showed that quickstep, waltz, rumba, and samba are more suitable for students to train in sports dance. Therefore, these four dances should be more promoted in the physical dance teaching activities in schools. Due to the limited length of the article, it is impossible to elaborate on the method in more detail, and the experiment is not comprehensive enough. It is expected that this topic can be studied in a more comprehensive way in the future.

Data Availability

All the data used to support the findings of the study are included within the work.

Conflicts of Interest

There are no potential competing interests in our work.

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